Chapter 10: Poliomyelitis

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I. Disease description

Poliomyelitis is a highly contagious disease caused by three serotypes of poliovirus. Infection with poliovirus results in a spectrum of clinical manifestations from inapparent infection to non-specific febrile illness, aseptic meningitis, paralytic disease, and death. Two phases of acute poliomyelitis can be distinguished: a non-specific febrile illness (minor illness) followed, in a small proportion of patients, by aseptic meningitis and/or paralytic disease (major illness). The ratio of cases of inapparent infection to paralytic disease ranges from 100:1 to 1000:1.

Following poliovirus exposure, viral replication occurs in the oropharynx and the intestinal tract. Viremia follows, which may result in infection of central nervous system cells. A specific receptor is needed for the virus to enter cells. Replication of poliovirus in motor neurons of the anterior horn and brain stem results in cell destruction and causes the typical clinical manifestations of poliomyelitis. Depending on the site of paralysis, poliomyelitis can be classified as spinal, bulbar, or spino-bulbar disease. Progression to maximum paralysis is rapid (2–4 days), usually associated with fever and muscle pain, and rarely continues after the temperature has returned to normal. Spinal paralysis is typically asymmetric, more severe proximally than distally, and deep tendon reflexes are absent or diminished. Bulbar paralysis may compromise respiration and swallowing. Between 2%–10% of cases of paralytic poliomyelitis are fatal. Infection with poliovirus results in lifelong, type-specific immunity.

Following the acute episode, many patients recover muscle functions at least partially, and prognosis for recovery can usually be established within 6 months after onset of paralytic manifestations.

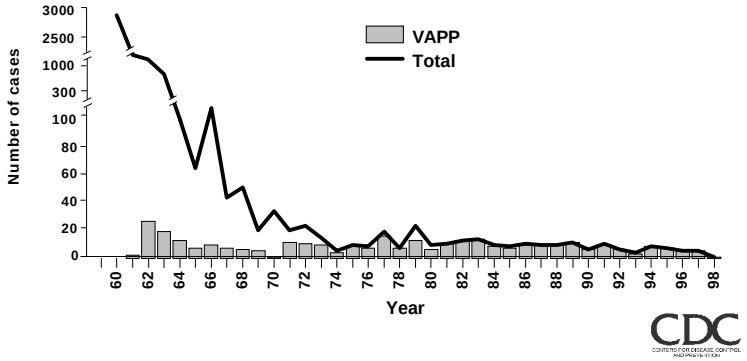
II. Background

Poliomyelitis became an epidemic disease in the United States at the turn of the century. Epidemics of ever-increasing magnitude occurred, with more than 20,000 cases of paralytic poliomyelitis reported in 1952. Following the introduction of effective vaccines, first inactivated poliovirus vaccine (IPV) in 1955, and oral poliovirus vaccine (OPV) starting in 1961, the reported incidence of poliomyelitis in the United States declined dramatically to <100 cases in 1965 and to <10 cases in 1973. With the introduction and widespread use of OPV (containing live attenuated poliovirus strains), vaccine-associated paralytic poliomyelitis (VAPP) was first recognized. By 1973, for the first time, more cases of vaccine-associated disease were reported than paralytic disease caused by wild poliovirus.[1]

The last cases of indigenously transmitted wild poliovirus disease were reported in 1979. Since then, apart from six cases of imported poliomyelitis, only one of which has occurred since 1986, all reported cases of paralytic poliomyelitis in the

United States have been vaccine-associated (Figure).[2,3] VAPP is a very rare disease with an average of eight reported cases annually during 1980–199, or one case reported for every 2.4 million doses of OPV distributed.[2,3] The risk of VAPP is highest following the first dose of OPV and among immunodeficient persons.

Total number of Reported Paralytic Poliomyelitis Cases* and the Number of Reported Vaccine-Associated Cases, United States, 1960 - 1998



Following the successful implementation of the polio eradication initiative in the Americas beginning in 1985, the last case of wild poliovirus-associated disease was detected in Peru in 1991. The hemisphere was certified as free of indigenous wild poliovirus in 1994.[4] In 1988, the World Health Assembly adopted the goal of worldwide eradication of poliomyelitis by the year 2000.[5] By 1998, substantial progress toward this goal has been reported: a more than 85% decrease in the number of reported cases of poliomyelitis was achieved; nearly all polio-endemic countries have conducted National Immunization Days and most countries have established sensitive surveillance systems for acute flaccid paralysis. The number of countries where wild polioviruses continue to be isolated has decreased substantially with sub-Saharan Africa and southern Asia remaining as the two major areas of wild poliovirus circulation.[6] Due to the successful implementation of the global poliomyelitis eradication initiative, the risk of importation of wild polio virus into the United States decreased substantially over the last decade. Nevertheless, the potential for importation of wild poliovirus into the United States remains until worldwide poliomyelitis eradication is achieved.[7]

Because inapparent infection with wild virus strains no longer contributes to establishing or maintaining poliovirus immunity in the United States, universal vaccination of infants and children is the only means of establishing and maintaining population immunity against poliovirus to prevent poliomyelitis cases and epidemics caused by importation of wild virus into the United States.

Population-based surveys have confirmed that the prevalence of poliovirus antibodies among school age children, adolescents and young adults in the United States is high (>90% to poliovirus types 1 and 2, and >85% to type 3).[8, 9] In addition, seroprevalence surveys in two inner-city areas of the United States --areas in which routine coverage was low -- during 1990-1991 found that >80% of all children 12-47 months of age had antibodies to all three poliovirus serotypes.[10] More recent data also demonstrate a high seroprevalence of antibody to all poliovirus serotypes among children aged 19-35 months who lived in the inner-city areas of four cities in the United States, with 96.8%, 99.8, and 94.5 seropositive to poliovirus types 1,2, and 3 respectively.[11] However, members of certain religious groups objecting to vaccination have remained susceptible to poliomyelitis. These groups appear to be highest risk for epidemic poliomyelitis. The last two outbreaks of poliomyelitis in the United States were reported among religious groups -- in 1972 among Christian Scientists [12] and in 1979 among the Amish.[1]

Since 1979, the only indigenous cases of poliomyelitis reported in the United States (n=144) have been associated with use of the live oral poliovirus vaccine (OPV). An additional six imported cases have been reported since 1979, the last of which occurred in 1993. Until recently, the benefits of OPV use (i.e., intestinal immunity, secondary spread) outweighed the risk for vaccine-associated paralytic polio (VAPP). In 1997, to decrease the risk for VAPP while maintaining the benefits of OPV, the Advisory Committee on Immunization Practices (ACIP) recommended a sequential schedule of inactivated poliovirus vaccine (IPV) followed by OPV.[13] Since 1997, the global polio eradication initiative has progressed rapidly, and the likelihood of poliovirus importation into the United States has decreased substantially. The sequential schedule has been well accepted, with no declines in childhood vaccination coverage observed, despite the need for additional injections.[14]

On the basis of these data, on June 17, 1999, the ACIP recommended an all-IPV schedule for routine childhood polio immunization in the United States to completely eliminate the risk of VAPP. As of January 1, 2000, all children should receive four doses of IPV at 2 months, 4 months, 6–18 months, and 4–6 years of age. OPV should be used **only** for the following special circumstances:

1. Mass vaccination campaigns to control outbreaks of paralytic poliomyelitis.
2. Unvaccinated children who will be traveling in <4 weeks to areas where polio is endemic.
3. Children of parents who do not accept the recommended number of vaccine injections. These children may receive OPV only for the third or fourth dose or both; in this situation, health-care providers should administer OPV only after discussing the risk for VAPP with parents or care givers.[15]

Availability of OPV is expected to be limited in the future in the United States. ACIP has reaffirmed its support for the global polio eradication initiative and use of OPV as the vaccine of choice to eradicate polio from the remaining countries where polio is endemic.[15]

III. Importance of rapid case identification

Rapid investigation of suspected poliomyelitis cases is critical to identifying possible wild poliovirus transmission. Rapid detection of wild virus-associated cases will permit the timely implementation of control efforts (mass vaccination with OPV) to limit the spread of imported wild poliovirus and maintain the elimination of wild poliovirus from the United States. Moreover, rapid investigation of suspected cases will allow collection of specimens for poliovirus isolation, which is critical for ruling out or confirming paralytic poliomyelitis, whether wild virus-associated or vaccine-related.

IV. Importance of surveillance

The poliomyelitis surveillance system serves to 1) detect importation of wild poliovirus into the United States; 2) characterize the epidemiology of VAPP; and 3) monitor the impact of changes in polio policy on the occurrence of VAPP.

V. Disease reduction goals

No cases of paralytic polio due to indigenously acquired wild poliovirus have been reported in the United States since 1979. The goal of maintaining elimination of paralytic poliomyelitis due to indigenous acquisition of wild poliovirus has been established for each year until the goal of global eradication is met.[16]

VI. Case definition

The following case definition for paralytic poliomyelitis has been approved by the Council of State and Territorial Epidemiologists (CSTE), and was published in May 1997 (Appendix 1).[17]

Clinical case definition

Acute onset of a flaccid paralysis of one or more limbs with decreased or absent tendon reflexes in the affected limbs, without other apparent cause, and without sensory or cognitive loss.

Case classification

Probable: A case that meets the clinical case definition.

Confirmed: A case that meets the clinical case definition and in which the patient has a neurologic deficit 60 days after onset of initial symptoms, has died, or has unknown follow-up status.

Comment. All suspected cases of paralytic poliomyelitis are reviewed by a panel of expert consultants before final classification occurs. Confirmed cases are then further classified based on epidemiologic and laboratory criteria. Only

confirmed cases are included in Table 1 in the MMWR. Suspected cases under investigation are enumerated in a footnote to the quarterly immunization table of the MMWR.

Confirmed cases are further classified based on epidemiologic and laboratory criteria.[18]

Indigenous case. Any case which cannot be proved to be imported.

Imported case. A case which has its source outside the United States. A person with poliomyelitis (United States resident or other) who has entered the United States and had onset of illness within 30 days before or after entry.[18]

VII. Laboratory testing

Laboratory studies, especially attempted poliovirus isolation, are critical to rule out or confirm the diagnosis of paralytic poliomyelitis.

For additional information on laboratory support for surveillance of vaccine-preventable diseases, see Chapter 19.

Virus isolation

To increase the probability of poliovirus isolation, at least two stool specimens should be obtained 24 hours apart from patients with suspected poliomyelitis as early in the course of disease as possible (ideally within 15 days after onset).

The likelihood of poliovirus isolation is highest from stool specimens, intermediate from pharyngeal swabs, and very low from blood or spinal fluid. The isolation of poliovirus from stool specimens contributes to the diagnostic evaluation but does not constitute proof of a causal association of such viruses with paralytic poliomyelitis.[1] Isolation of virus from the cerebrospinal fluid (CSF) is diagnostic but is rarely accomplished. To increase the probability of poliovirus isolation, at least two stool specimens and two throat swabs should be obtained 24 hours apart from patients with suspected poliomyelitis as early in the course of the disease as possible (i.e., immediately after poliomyelitis is considered as a possible differential diagnosis), but ideally within the first 15 days after onset of paralytic disease. Specimens should be sent to the state or other reference laboratories for primary isolation. Laboratories should forward isolates to CDC for intratypic differentiation to determine whether the poliovirus isolate is wild or vaccine-related.

Isolation of wild poliovirus constitutes a public health emergency and appropriate control efforts must be initiated immediately (in consultation between health-care providers, the state and local health departments, and CDC).

Serologic testing

Serology may be helpful in supporting or ruling out the diagnosis of paralytic poliomyelitis. An acute serum specimen should be obtained as early in the course of disease as possible, and a convalescent specimen should be obtained 3 weeks later. A four-fold rise between the acute and convalescent specimens suggests poliovirus infection. Non-detectable antibody titers in both specimens

may help rule out poliomyelitis, but may be falsely negative in immunocompromised persons, who are also at highest risk for paralytic poliomyelitis. In addition, neutralizing antibodies appear early and may be at high levels by the time the patient is hospitalized; thus, a four-fold rise may not be demonstrated. One of the limitations of serology is the inability to distinguish between antibody induced by vaccine-related poliovirus and antibody induced by wild virus. Serologic assays to detect anti-poliovirus antibodies are available in most commercial and state public health laboratories.

CSF analysis

The CSF usually contains an increased number of leukocytes — from 10 to 200 cells/mm^3 (primarily lymphocytes) and a mildly elevated protein, from 40 to 50 mg/100 ml. These findings are non-specific and may result from a variety of infectious and noninfectious conditions.

VIII. Reporting

Each state and territory has regulations and/or laws governing the reporting of diseases and conditions of public health importance (Appendix 2).[19] These regulations/laws list the diseases that are to be reported, and describe those persons or groups responsible for reporting, such as health-care providers, hospitals, laboratories, schools, day care facilities, and other institutions. Contact your state health department for reporting requirements in your state.

Reporting to CDC

Because poliomyelitis has become very rare (only six cases were reported during 1997-98), each reported case of suspected poliomyelitis should be followed up by local and state health departments in close collaboration with CDC. At the direction of the state health department, CDC (Infant Immunization Activity, National Immunization Program, 404-639-8255) will provide consultation regarding the collection of appropriate clinical specimens for virus isolation and serology, the initiation of appropriate consultations and procedures to rule out or confirm poliomyelitis, the compilation of medical records, and most importantly, the evaluation of the likelihood that the disease may be caused by wild poliovirus.

Information to collect

Demographic, clinical, and epidemiologic information are collected to 1) determine whether the suspected case meets the case definition for paralytic poliomyelitis, and 2) determine whether the disease may be caused by wild poliovirus or is vaccine-related. Additional information may also be collected at the direction of the state health department.

- Demographic information

- Vaccination status including

—Number of doses of poliomyelitis vaccine
—Time since last dose of poliomyelitis vaccine
—Type of vaccine (IPV or OPV)

• Clinical details including
—Immunologic status of case-patient
—Date of onset of symptoms
—Complications and hospitalization

• Laboratory information including
—Serologic test results

• Travel and exposure history including
— Recent travel to polio-endemic areas
— Contact with persons recently returning from polio-endemic areas
— Contact with recent OPV recipient
— Setting (i.e., is case-patient a member of a group objecting to vaccination)

• Dates including
—Date reported to health department
—Date of initiation of case investigation

Travel History

Because the last cases of paralytic poliomyelitis due to indigenously acquired wild poliovirus infection in the United States were reported in 1979, it is likely that wild poliovirus in a suspected case-patient is imported, either by the suspected patient directly or by a contact of the case-patient. Results of virus isolation and differentiation may not be available at the time of the case investigation. Therefore, to rule out the possibility of imported wild poliovirus, a detailed travel history of suspected cases and of other household and non-household contacts should be obtained. Any history of contacts with visitors, especially those from polio-endemic areas, might be particularly revealing.

Setting

Because the last two outbreaks of poliomyelitis in the United States were reported among Christian Scientists in 1972[12] and the Amish in 1979,[1] a suspected case of poliomyelitis reported from a group objecting to vaccination should be assigned the highest priority for follow-up and collection of specimens. In addition, isolation of wild poliovirus from residents of Canada in 1993[20] and 1996[7] demonstrates the potential for wild poliovirus importation into this continent. The strain isolated in 1993 was linked epidemiologically and by genomic sequencing to the 1992 poliomyelitis outbreak in the Netherlands, and the 1996 isolate was from a child who had recently visited India.

IX. Vaccination

Beginning January 1, 2000, all children should receive four doses of IPV at 2 months, 4 months, 6–18 months, and 4–6 years of age.

OPV should be used only for the following special circumstances:[15, 21]

1. Unvaccinated children who will be traveling in <4 weeks to areas where polio is endemic.

2. Children of parents who do not accept the recommended number of vaccine injections. These children may receive OPV only for the third or fourth dose or both; in this situation, health-care providers should administer OPV only after discussing the risk for VAPP with parents or care givers.

3. Mass vaccination campaigns to control outbreaks of paralytic poliomyelitis.

All children should complete their primary vaccination for poliomyelitis before entering school. All children who had previously received a primary series with only OPV or only IPV (three doses) should receive a fourth dose of IPV before entering school (e.g., between 4-6 years of age) to complete the recommended schedule.

If the poliovirus vaccines are administered according to their licensed indications for minimum ages and intervals between doses, administration of four doses of IPV or OPV in any combination by 4-6 years of age is considered a complete poliovirus vaccination series.[13]

For unvaccinated adults only IPV is recommended. The primary series of IPV for adults consists of three doses of IPV. Two doses can be given at a 4-8 week interval; the third dose should follow 6-12 months after the second dose.[13]

In circumstances where accelerated protection is needed, the minimum interval between doses of poliovirus vaccine (IPV or OPV) is 4 weeks. Previously vaccinated persons who are considered to be at increased risk of exposure to poliovirus (e.g., travelers to polio-endemic areas, laboratory workers) should receive a single additional dose of OPV (not recommended for persons aged >18 years) or IPV.[13]

X. Enhancing surveillance

A number of activities can improve the detection and reporting of cases and improve the comprehensiveness and quality of reporting. Additional surveillance activities are listed in Chapter 16.

Promoting awareness. Because of the severity of poliomyelitis disease (i.e., paralytic disease), clinicians are often the first to suspect the diagnosis of

poliomyelitis and they are the key to timely reporting of suspected cases. However, disease reporting by clinicians is often delayed because it is only after other differential diagnoses are ruled out that the diagnosis of poliomyelitis is considered. Efforts should be made to promote physicians' awareness of the importance of prompt reporting of suspected cases to the state and local health department and the CDC, and the need to obtain stool and serum specimens early in the disease course.

Ensuring laboratory capabilities. Make sure that the state laboratory or other easily accessible laboratory facility is capable of performing, at a minimum, primary virus isolation and serologic testing for poliovirus.

Obtaining laboratory confirmation. Appropriate stool specimens (two specimens taken at least 24 hours apart during the first 15 days after onset of paralytic disease) should be collected.

Active surveillance. The diagnosis of a case of poliomyelitis, particularly in a member of a group that refuses vaccination (such as the Amish or Christian Scientists), should prompt immediate control measures (mass vaccination with OPV) as well as active surveillance activities. These activities should include active case finding at area hospitals or any other sources of acute medical care.

XI. Case investigation

Guidelines and a worksheet for the investigation of suspected cases of poliomyelitis are included as Appendix 16. Suspected cases of poliomyelitis should be reported immediately to the state health department. At the direction of the state health department, CDC should be contacted at 404-639-8255. Timely collection of stool specimens is important in establishing the diagnosis and determining appropriate control measures, in the event of wild poliovirus isolation (See section VII, “Laboratory testing: Virus isolation”).❖

References

1. Strebel PM, Sutter RW, Cochi SL, et al. Epidemiology of poliomyelitis in the United States one decade after the last reported case of indigenous wild virus-associated disease. Clin Infect Dis 1992;14:568-79.

2. CDC. Paralytic poliomyelitis --United States, 1980-1994. MMWR 1997;46:79-83.

3. Prevots DR, Sutter RW, Strebel PM, et al. Completeness of reporting for paralytic polio, United States, 1980–1991. Arch Pediatr Adolesc Med 1994;148:479-85.

4. CDC. Certification of poliomyelitis elimination -- the Americas, 1994. MMWR 1994;43:720-2.

5. World Health Assembly. Global eradication of poliomyelitis by the year 2000. Geneva, Switzerland: World Health Organization, 1988; resolution no. 41.28.

6. CDC. Progress toward global eradication of poliomyelitis, 1997. MMWR 1998;47:414-9

7. Ministry of Health, Ontario. Wild type poliovirus isolated in Hamilton. Public Health and Epidemiology Report, Ontario 1996;7:51-2.

8. Kelley PW, Petruccelli BP, Stehr-Green P, et al. The susceptibility of young adult Americans to vaccine-preventable infections. A national serosurvey of US army recruits. JAMA 1991;266:2724-9.

9. Orenstein WA, Wassilak SGF, Deforest A, et al. Seroprevalence of polio virus antibodies among Massachusetts schoolchildren. In: Program and Abstracts of the 28th Interscience Conference on Antimicrobial Agents and Chemotherapy (abstract no. 512). Washington, DC: American Society for Microbiology.

10. Chen RT, Hausinger S, Dajani A, et al. Seroprevalence of antibody against poliovirus in inner-city preschool children: Implications for vaccination policy in the United States. JAMA 1996:275:1639-45.

11. Prevots R, Pallansch MW, Angellili M, et al. Seroprevalence of poliovirus antibodies among low SES children aged 19-35 months in 4 cities, United States, 1997-1998. Presented at the 39th Interscience Conference on Antimicrobial Agents and Chemotherapy, San Francisco, CA, Sep. 26-29. Abstract 158.

12. Foote FM, Kraus G, Andrews MD, et al. Polio outbreak in a private school. Conn Med 1973:37:643-4.

13. CDC. Poliomyelitis prevention in the United States: Introduction of a sequential vaccination schedule of inactivated poliovirus vaccine followed by oral poliovirus vaccine: Recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR 1997;46(RR-3):1-25.

14. CDC. Impact of the sequential IPV/OPV schedule on vaccination coverage levels --United States, 1997. MMWR 1998;47:1017-9.

15. CDC. Recommendations of the Advisory Committee on Immunization Practices: Revised recommendations for routine poliomyelitis vaccination. MMWR 1999;48:590.

16. United States Department of Health and Human Services. Office of Public Health and Science. Healthy People 2010 Objectives: Draft for Public Comment. Washington, D.C. September 15, 1999:22-9.

17. CDC. Case definitions for infectious conditions under public health surveillance. MMWR 1997;46(RR-10):39.

18. Sutter RW, Brink EW, Cochi SL, et al. A new epidemiologic and laboratory classification system for paralytic poliomyelitis cases. Am J Pub Health 1989;79:495-8.

19. Roush S, Birkhead G, Koo D, et al. Mandatory reporting of diseases and conditions by health care professionals and laboratories. JAMA 1999;282:164-70.

20. CDC. Isolation of wild poliovirus type 2 among members of a religious community objecting to vaccination- Alberta, Canada, 1993. MMWR 1993;42:337-9.

21. CDC. Recommended childhood immunization schedule -- United States, 1999. MMWR 1999;48:12-6.